WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

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THE RIPE ROT or MUMMY DISEASE OF GUAVAS

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INSTITUTE

BY JOHN L. SHELDON

The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application.
Address Director of Agricultural Experiment Station, Morgantown, W. Va.

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The Ripe Rot or Mummy Disease of Guavas.

By John L. Sheldon.

Introduction.

While walking through the greenhouses of the United States Department of Agriculture at Washington, D. C., in company with Mr. A. F. Woods, Assistant Chief of the Bureau of Plant Industry, the writer noticed among some guavas that were ripening at the time (December 20, 1903) a number that were brown and shriveled. Upon closer examination it was found that the shriveled fruits had not naturally dried and remained on the trees after ripening, but that they had been attacked by some fungus of the anthracnose type. The disease was new to the writer, and with Mr. Woods' permission, specimens of the infected fruits were collected for future examination and study.

Importance and Distribution.

It was not on account of the economic importance of the ripe-rot or mummy disease of the guava that a study of the life-history of the fungus causing it was begun, for at that time the disease was not thought to be of enough economic importance to warrant a careful investigation. It was studied, rather, as a side line along with the anthracnose of cucurbits, and more especially on account of its similarity to the bitter-rot disease of apples.

Judging from the effects of the fungus on the guavas in the greenhouse, it would seem to be as destructive to the guava as the bitter-rot is to the apple. To what extent it damages the guava crop under natural conditions, the writer can not say from personal observations, never having had the privilege of

seeing guavas growing under natural conditions, either wild or cultivated.

In order to obtain some data as to the amount of damage caused by the disease, and specimens of the infected fruits from different localities, letters of inquiry were sent to Porto Rico, Florida, California, and Australia.

Mr. O. W. Barrett, botanist at the Porto Rico experiment station, replied as follows: "In regard to the occurrence of the 'mummy' disease of the guava in Porto Rico, will say that it is quite prevalent throughout the island on both forms of *Psidium guaiava*. It also occurs occasionally on the semi-cultivated guavas here, but does practically no damage, the trees always cropping heavily, and occasionally twice in a year." Later he wrote, "Can you suggest any possible treatment for this mummy disease? It is really a serious matter and I have not recommended the planting of guavas as a crop here thus far. Several canning companies would probably consider the planting of guavas seriously if it were not for this disease."

Mr. N. A. Cobb, of the Department of Agriculture of New South Wales, Australia, wrote, "I notice that the disease does more harm to the guavas here than any other disease of this fruit with which I am acquainted. Of course the guava does not cut much of a figure in our fruit industry, so I cannot say that the loss amounts to much from a monetary point of view. In particular instances the loss is one that requires attention, but these instances are necessarily few, as few grow the fruit."

Correspondents in California and Florida wrote that the disease occurs there, but that it is of no special importance as yet; while others wrote that the disease has not been observed. The disease also occurs in Mexico, but no data have been obtained with respect to its prevalence and the damage it causes.

Appearance of the Infected Fruit.

There was considerable difference in the appearance of the infected fruits from different localities. Those collected at Washington, D. C., had circular, brown, decayed areas on them, the diameter of the decayed area depending upon the progress of

the disease. In the more advanced stages, there were numerous masses of salmon colored conidia scattered over the decayed areas, resembling the masses of conidia of a *Colletotrichum* or a *Gloeosporium*. A microscopical examination showed that the fungus corresponded more nearly to a *Gloeosporium*, no setae being present in and around the acervuli. The entire fruit finally became decayed and considerably wrinkled and shrunken. Plate I, fig. 1.

The specimens from Porto Rico and Florida, collected by Mr. O. W. Barrett and Mr. P. H. Rolfs, respectively, were very hard and smooth, and more or less spotted with masses of conidia. Many of the conidia had evidently been washed off by the rains. Plate I, figs. 2 and 3.

History and Description of the Disease.

It was thought when the specimens were collected by the writer in Washington that the disease must be a comparatively new or rare one, at least one that had not received a great amount of attention. No record of it could be found in any of the literature on plant diseases that was available in the libraries of the West Virginia University and Experiment Station. There was no reference to a *Gloeosporium* on guavas in Saccardo's Sylloge Fungorum, neither were there any mounted specimens of the infected fruits in the pathological herbarium of the United States Department of Agriculture until some were furnished by the writer.

Mrs. Flora W. Patterson, mycologist of the United States Department of Agriculture, very kindly offered to examine the publications on file in the different libraries of the Department, and reported that there was an article by Delacroix on a disease of guavas caused by a *Gloeosporium*. This article was sent to the writer by the Libarian of the Department. It is the only one that the writer has seen which gives a general description of the disease and the fungus causing it. The article was published about eight months before the specimens of guavas were collected in Washington.

Delacroix's description was made from specimens of guavas

that had been preserved in alcohol and shipped from Mexico to France. After a general, popular description, followed by a cut, is the following:

"Diagnose: *Gloeosporium Psidii* G. Del.

Maculis distincte limitatis, brunneis; conceptaculis sub cuticulo enascentibus, mox superficialibus, 90—120μ latis, sterigmatibus hyalinis, cylindricis, 15—18×4—5μ; sporulis ellipticoovalis, hyalinis, levissime granulatis, 10—13×4—6μ.

In epicarpio Psidii pomiferi. Mexico."

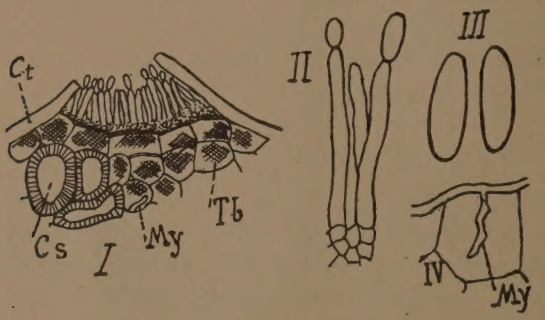

Fig. 1. Transverse section through epicarp of guava, after Delacroix. Redrawn from Bul. Soc. Mycol. France.

I. Relation of a conceptacle to the cuticle and underlying tissues.

II. Basidia with conidia. III. Conidia. IV. Mycelium in cell.

About two months after the publication of Delacroix's article, Cobb published the results of his cross-inoculation experiments with the ripe-rot fungi of different fruits, among them being the ripe-rot of the guava.

The specimens that have been examined agree very well with the diagnosis made by Delacroix with the exception of the spores or conidia. Those from the Washington specimens were considerably larger, even after having been kept in a dry laboratory for over two years. Ten conidia, selected at random from several hundred, measured 16—20×4.5—6.4μ, with an average of 19×5.5μ. The conidia from the Porto Rico specimens were from

1 to 2μ shorter than those from Washington. It will be seen that the length of these conidia is approximately 5 μ more than those measured by Delacroix. However, this difference may be accounted for in part from the fact that the conidia which he measured had possibly been shrunken by the alcohol in which the guavas were preserved, or they may have been immature. Evidently Delacroix did not notice the round spot that is normally present near the center of the conidia and which is not granular like the remainder of the cell contents. Some of the conidia were slightly curved and a few were narrowed at one end.

Life-History of the Fungus.

Inoculations.

Apples.—Upon returning from Washington, inoculations were made directly from guavas into apples. Pure cultures of the fungus were used for much of the later work. The writer did not know then that Cobb had made the same kind of inoculations and thought the anthracnoses, or ripe-rots, of the guava and other fruits were possibly caused by the same fungus.

A few of the apples were washed with water, then with a solution of corrosive sublimate (5:1000), rinsed with sterile water, and finally wiped with a sterile towel before they were inoculated, but nearly as good results were obtained without this extra trouble.

The inoculations were made by taking a few conidia directly from a guava, or a pure culture, and inserting them under the skin of an apple with a sterile needle. Baldwins, Bellflowers and an unknown variety of a yellow sweet apple were used. After the apples were inoculated, they were placed on a glass plate and covered with hand-glasses in order to exclude insects. When there were indications that there was too much moisture under the hand-glasses, the apples were removed and placed in open jars, the insects being kept out by tying a piece of fine muslin over the opening.

After two days the effects of the fungus could usually be seen as a circular brown spot around the place where the inoculation had been made. The size of the spot increased more rapidly

on some apples than on others, even of the same variety, especially when the inoculation was made in a bruise, and more rapidly on the sweet variety and the Bellflower than on the Baldwin. Differences in temperature, ripeness, texture, and acidity probably made a difference in the rate of growth of the fungus, and a like difference in the size of the infected area. There were no indications of the presence of the fungus except where the inoculations were made.

In about five or six days, longer in some instances, small black specks began to appear in the brown and decaying areas. These specks increased in size until they broke open the epidermis of the apple, when masses of conidia began to ooze out through the openings. Plate II, Figs. 1 and 2. The color of the masses of conidia varied from a dirty white to a salmon. Occasionally the conidia oozed out in a straight thread or curled to one side. The newly formed conidia were 12—13.5×4.5—6 μ, about the same size as those taken from the guava by Delacroix (10—13×4—6 μ), but considerably shorter than those taken from the Porto Rico and Washington specimens by the writer.

The black specks which appeared under the epidermis of the apples a few days after they had been inoculated were what Delacroix called conceptacles. They were composed of rows of cells, with a more or less parallel arrangement, terminating in hyphae (basidia), which bore the conidia. Plate III, fig. 1. The gradual development of the conceptacles finally causes a rupturing of the epidermis, followed by a liberation of the conidia.

Unless the apples happened to be infected with other fungi, like the blue molds, the rot extended from the point of inoculation over the entire surface. After a few days the rotted area became somewhat shrunken, wrinkled and blackened from the center outward. When there was sufficient moisture under the hand-glasses, the masses of conidia changed from pink to black. A microscopical examination showed that they had germinated and anastomosed so that they formed a firm body resembling a pycnidium, from the inside of which conidia were still being formed and given off. The apples were sometimes covered by a

felted mycelium when they were exposed to an excess of moisture. Plate II, fig. 3. They finally shriveled and shrunk to about half their normal size.

The fungus spread from the point of inoculation to the inside of the apple in the form of a cone with its apex at the core and its base on the surface of the apple. Plate II, fig. 4. This cone-shaped portion was brown and bitter, what may be called a "nasty bitter" for lack of a better descriptive term.

Inoculations made in young winter apples, about an inch in diameter, and still on the tree, were unsuccessful. Inoculations in young Sweet Boughs and other sweet apples just beginning to show signs of ripening were successful in the laboratory. Good results were obtained from the sweet apples when inoculated on the trees a few weeks later. The rot developed very rapidly and conidia were produced in abundance. Most of the apples fell off after the rot had begun to develop. What apples did not fall off were shaken off by boys so that the rot did not have an opportunity to spread. None was observed on any of the other apples.

Damson Plums.—Several inoculations made from pure cultures into Damson plums were successful, the pink masses of conidia appearing in a few days.

Apple Trees.—No results were obtained from the use of conidia from guavas or pure cultures when inoculated into the young twigs or branches of apple trees. There is a possibility that the inoculations were not made at the right stage of growth.

From inoculations made with the conidia into apples, it will be seen that the macroscopic characteristics of the bitter-rot of the apple were reproduced in detail. The rotted portions of the apples were bitter, the same as they are when they have the bitter-rot.

Artificial Cultures.

Apple-agar was used as a culture medium for most of the artificial cultures. It was prepared by heating ground apples in three times their weight of distilled water at a temperature below boiling until the pieces of apple were soft. The decoction

was then filtered and normal NaOH added to the filtrate to reduce the acidity, not enough to neutralize it, but to leave it slightly acid to litmus paper. One per cent. of agar-agar was then added. After the agar-agar had been dissolved by heating, the medium was filtered and sterilized.

Plate Cultures.—Plate cultures were made after the usual manner by the addition of conidia to tubes of melted apple-agar. Blank plates were also made and conidia taken from guavas planted in them. This latter method gave nearly as good results as the usual poured plate method, the pure cultures being removed from the plates in each case. Sub-cultures were made from the plates into other plates and test tubes where the fungus developed very rapidly.

The mycelium was at first white, gradually changing to a dark gray. Pink masses of conidia began to appear in the plates and test tubes after a few days; they were occasionally arranged concentrically but more often scattered about, being abundant at the edge of the plate where the mycelium extended up the side of the Petri dish. Some of the newly formed conidia germinated after a few days, and the plates became covered with a dense, felted mycelium.

A few plates were coated wholly or in part with a thin layer of sterile paraffin. Conidia were then introduced through the layer of paraffin into the apple-agar beneath. The fungus made a good growth beneath the paraffin layer, but no conidia were produced until the mycelium reached the edge of the layer, or holes that were pricked through the layer with a needle, then they were produced in the same way that thy were in the ordinary plates. The paraffin was used in order to determine whether conceptacles would be formed beneath it and rupture it in order to liberate the conidia, the same as was done when it grew in the guavas and apples, but none were formed. A few conidia were formed on the surface of the paraffin after a number of weeks, but they were the result of filaments penetrating the paraffin and then producing conidia on the surface.

The conidial masses, which were usually pink at first, germinated and formed black bodies resembling pycnidia, the same as

those previously described that were found on the inoculated apples. Conidia were given off from these bodies in much the same way that they are from the pycnidia of certain of the *Sphaeropsideae*. The pycnidia-like bodies became more and more chimney-like from the addition of the germinating and anastomosing conidia which were produced at the base and sides of the cavity. Plate III, fig. 3.

Test-tube Cultures.—Besides the test-tube cultures on apple-agar referred to above, others were made on muskmelon-agar and lactose-agar, but not with very satisfactory results. The cultures in test tubes were not in general as satisfactory as those made in Petri dishes and flasks, except for preserving stock cultures.

Drop Cultures.—Conidia from the guavas germinated in drop cultures of water in from four to six hours. The conidia did not lose their capacity for germination for several months if they were kept dry. In germinating, a germtube appears at one or both ends of the conidium, occasionally at the side. Many of the conidia became from one to three septate during germination. Plate IV, figs. 3 and 8.

There was a marked change in the size and distribution of the granules in the conidia from the time they were placed in the water until after the branched mycelium had begun to develop. The difference in the size of the granules was considerable as one generation of spores followed another in drop cultures of apple-agar, especially when they could be traced from one spore. In the younger conidia they were very small and uniformly distributed, while in the older and those that were germinating, they were large and unevenly distributed. Plate IV, fig. 22.

The drop cultures proved to be a very satisfactory means for watching the development of the fungus from the time a conidium began to show signs of germinating until one generation after another of conidia had been produced and in turn had germinated. The drop cultures made from apple-agar were exceptionally good for this work.

The conidia were formed on the ends of hyphae by a gradual enlargement of the hypha, the conidium finally breaking off,

other conidia being formed in the same manner. Plate IV, figs. 18 and 21. In the way the conidia were produced, this fungus does not differ from many of the Hyphomycetes. The conidia collected on the surface of the plates as small pink masses (Plate IV, figs. 18 and 19), and when a hypha extended out into the air the conidia formed a small ball. Plate IV, fig. 20. The conidia are somewhat gelatinous, and this causes them to hang together when moist.

Conidia were produced sparingly in drop cultures of water, Instead of conidia, there were brown, spore-like bodies, which for convenience were called chlamydospores, although they may not have been real chlamydospores. These were borne on the ends of hyphae and also in the filaments. In shape they were spherical to ovate and oblong and contained one or more vacuoles. Plate IV, figs. 9-17. No attempt was made to germinate them in order to determine if they were similar to spores. The chlamydospore-like bodies were formed in water cultures and in nutrient media after the food had probably been exhausted. None were found in guavas nor in the inoculated apples. One or more of the cells in the filament adjacent to the spore-like bodies were often colored brown.

By means of the drop cultures and a camera lucida, it was possible to draw in outline the development of the fungus through three successive generations of conidia from a conidium taken from a guava. The difference in the size of the conidia as the food became exhausted being very noticeable. Plate IV, fig. 22. A difference of five microns between the conidia from the guavas and those from the inoculated apples may have been due to the food supply—that furnished by the guava being more suitable to the development of the fungus than that furnished by the apple.

The germinating conidia and mycelium anastomosed freely with one another. Plate IV, fig. 10. Some of the conidia which did not germinate became brown, others becoming so after germination.

The conidia that developed in the apple-agar cultures agreed fairly well in shape and size with those obtained from the inocu-

lated apples, averaging from 13.5—18×4.5—6μ, the longest ones being rare, and usually narrow in proportion to their length.

Flask Cultures.—Besides the cultures made in plates, test tubes and hanging drops, others were made in flasks. Corn meal was put in some of the flasks to the depth of about half an inch and enough hot apple-agar added to wet the meal. The flasks with their contents were then sterilized and finally inoculated from pure cultures of the fungus. The other flasks were filled to about the same depth with corn meal mush made by cooking the corn meal in eight times its weight of distilled water. These flasks were then sterilized and inoculated from pure cultures.

There was a rapid development of the mycelium, showing that corn meal alone or combined with apple-agar made a suitable medium for the growth of the fungus. Conidia were formed to some extent, the pink masses being visible round the sides of the flasks.

Small black bodies, from a mere speck to five millimeters in diameter, were produced in the felt-like mycelium that covered the medium, but they could not be seen except where they were lying near the sides of the flasks. They were also scattered through the medium, for the most part near the surface. A microscopical examination of some of these bodies showed that the outside was composed of a layer of brown filaments, the inside being composed of colorless ones; others contained conidia borne on basidia in the same way that the spores are in an immature pycnidium. Similar pycnidia-like bodies were found in the guavas, and they have also been observed by the writer in artificial cultures of *Colletotrichum lagenarium* (Pass.) Ell. & Hal. They were evidently what Delacroix called the conceptacles. Structurally they were very much like the bodies that formed beneath the epidermis of the inoculated apples and which produced the masses of conidia. Plate III, fig. 2.

Formation of Ascospores.

An abstract in Science refers to the finding of the ascigerous stage of the fungus in some old cultures by the writer. In these

cultures, which were originally obtained from a guava received from Porto Rico, it was noticed that there were papillæ scattered through the felted mycelium, caused by hard black bodies lifting the mycelium from the medium. These bodies were about a millimeter in diameter and were composed of a number of smaller bodies, like pycnidia or perithecia, growing together. After a careful search it was found that there were colorless, one-celled spores in a few of them, but for the most part they were empty or sterile. Occasionally asci in different stages of development were found, showing that the bodies were perithecia and not pycnidia.

In general, the perithecia were simple, or now and then with their walls united, or a large one contained one or more small ones. There were some from 200—300μ in diameter and many smaller ones, spherical, except when crowded against one another, and only an occasional one with a distinct beak and ostiolum. Plate IV, figs. 23 and 24. The walls of the young perithecia were membranaceous and composed of polygonal cells; the older ones were hard, approaching carbonaceous.

Combined with the asci were masses of filaments corresponding to paraphyses. As soon as water came in contact with the content of the perithecia, the mature asci, and what was taken for paraphyses, gradually disappeared, apparently dissolving in the water. On account of a scarcity of material and the ephemeral nature of the contents of the perithecia, it was impossible to get as clear a conception of the asci and paraphyses as could have been obtained otherwise. In general, the asci were cylindrical to broadly clavate, rather blunt at the apex and with a short pedicel. They varied in length, as most asci do even in the same perithecium, but were about 45-55 x 9-10μ Some were possibly a little longer. The usual number of spores was eight, one ascus having only six, and the spores were sub-biseriate in the asci. Plate IV, figs. 26-29. The spores resembled the conidia of the Gloeosporium stage and could scarcely be distinguished from the curved conidia; they were mostly curved, continuous, hyaline, granular, and usually contained a distinct spot near the center without granules, or one or two vacuoles. Plate IV, figs. 25 and 28.

Average spores, taken from the growing cultures, measured 13-15 x5-6 μ; ten from the microtome sections were 12-17.5 x 3.5-5 μ, being somewhat less than the former.

The Name of the Fungus.

This disease of the guavas is one that corresponds to the anthracnoses of a number of fruits and vegetables. Macroscopically the acervuli are almost identical with those of the anthracnose of the watermelon, the bean, the apple, the eggplant, the pepper, and of the fruits of other plants, but the conidia differ from the conidia of some of these, and no setae have been found in connection with the acervuli in either the guavas, inoculated apples, or the artificial cultures. The conidial stage is characteristic of the genus *Gloeosporium*, and the fungus as it was found on the guavas by Delacroix was called *Gloeosporium Psidii*. It has been shown by the writer that the fungus has an ascigerous stage, corresponding in nearly every particular to the genus *Glomerella*. Such being the case, and following the custom of other investigators of this group of fungi, the name of this fungus would be changed from *Gloeosporium Psidii* G. Del. to *Glomerella Psidii* (G. Del.)

Summary and Recommendations.

The ripe-rot or mummy disease of guavas has been reported from Mexico, Porto Rico, Florida, and Australia. In Porto Rico and Australia it is often very destructive to the crop of ripening guavas, being of considerable economic importance on account of the value of the fruit for preserving purposes.

Brown spots appear on the ripening fruits, the size of the spots gradually increasing until the entire fruit becomes affected, the decayed fruits finally falling off or the "mummies" remaining on the trees.

The fungus causing the disease was first described as *Gloeosporium Psidii* by Delacroix in 1903. It has been successfully inoculated into a number of fruits directly from guavas, and grown in various artificial culture media.

Two distinct conidial stages have been observed; one, with the condiia borne on hyphae after the usual manner of many of the

Hyphomycetes; the other, with conidia on basidia after the manner of the *Melanconiae.* An ascigerous stage, very similar to that of the genus *Glomerella,* was obtained in artificial cultures.

The writer has not been able to find any great amount of difference between this fungus and the descriptions of the one causing the bitter-rot of the apple. The difference has not been considered sufficient to warrant making it another species. Their effects on apples were practically identical; their growth in artificial cultures was much the same; and their conidia, perithecia and ascospores were produced in much the same way and showed about the same variations in size and shape. While the asci of the guava fungus obtained by the writer were not of the same general shape as those figured by Clinton for the bitter-rot fungus (his being more pointed at the apex), they agreed very nearly with those figured by von Schrenk & Spaulding.

The one point of difference, and one that has been made of considerable importance in the classification of the Pyrenomycetes, was the presence of paraphyses. Clinton says "There were no signs of paraphyses" in his cultures of the bitter-rot fungus, and von Schrenk and Spaulding, who also made a rather exhaustive study of the same fungus, do not mention the finding of paraphyses, in fact, they described the genus *Glomerella* as "aparaphysate."

The writer has demonstrated to his own satisfaction a number of times that there were paraphyses present in the ascigerous stage obtained from species of *Gloeosporium* and *Colletotrichum.* The paraphyses were seen when the contents of the perithecia were teased out, and serial sections of the perithecia showed the asci imbedded in a matrix, such as would be present if the asci were surrounded by paraphyses. The writer has made a recent study of the ascigerous stage of *Glomerella rufomaculans* (Berk.) Sp. & von Sch., by means of pure cultures isolated from a Baldwin apple, and has found that it also has paraphyses.

There is a possibility that further investigation will show that paraphyses are present in most, if not all, species of *Glomerella.* It is, therefore, recommended that the phrase *paraphyses sometimes present* be included in future descriptions of the genus *Glomerella,* or an equivalent.

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DESCRIPTION OF PLATES.

(Halftones from photographs and photomicrographs by Mr. W. E. Rumsey.)

Plate I. Guavas affected with the ripe-rot or mummy disease. Natural size. The white spots on the fruits represent masses of conidia. Fig. 1.—From greenhouse of the United States Department of Agriculture, Washington, D. C. Fig. 2.—From Mayaguez, Porto Rico. Fig. 3.—From Eldred, Florida.

Plate II. Apples inoculated with conidia of the ripe-rot fungus. Fig. 1.—The white spots on the apple show the masses of conidia just beginning to collect. Fig. 2.—A more advanced stage of the rot than shown by fig. 1. Fig. 3.—A still more advanced stage of the rot, the apple being completely covered by the mycelium. The black specks near the stem-end of the apple are masses of conidia that have germinated and anastomosed. Fig. 4.—Section through an inoculated apple, showing the decayed, cone-shaped portion at the left, caused by the fungus.

Plate III. Fig. 1.—Section through the skin of an inoculated apple, showing a conceptacle with basidia bearing conidia that has broken through the epidermis. The color of the conidia is the result of using Flemming's solution as a fixing reagent. Fig. 2.—Section of one of the bodies referred to in the text that formed in the cultures of corn meal mush. Fig. 3.—Section of a chimney-like body, composed of conidia that have germinated and anastomosed, with conidia in different stages of maturity inside. Fig. 4.—Section through two perithecia joined together. The larger shows the beak and ostiolum and rows of ascospores.

Plate IV. Microscopic characters of the ripe-rot fungus in various stages. Figs. 1 and 2.—Conidia from guava. Figs 3-7.—Germination of conidia and the development of mycelium. Figs. 6-8.—Septa formed in conidia during germination. Figs. 9-17.—Chlamydospore-like bodies. Fig. 10.—Conidia anastomosing. Figs. 18-22.—Conidia in different stages of development. Figs. 18 and 19.—Masses of conidia collecting on poured plate. Fig. 20.—Masses of conidia on end of hypha which has extended out into the air. Fig. 22.—First and second generations of conidia from a conidium. Figs. 23 and 24.—Outlines, showing sections of rostrate perithecia. The walls of the perithecia appear thicker than they really are on account of the thickness of the sections. Fig. 25.—Ascospores. Fig. 26.—An immature ascus. Fig. 27.—An ascus containing six ascospores. Figs. 28 and 29.—Broken asci with ascospores.

PLATE I

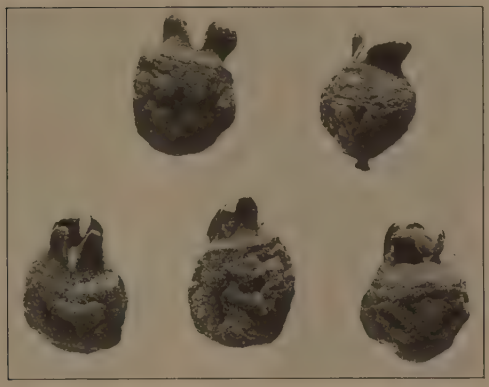

FIG. 1

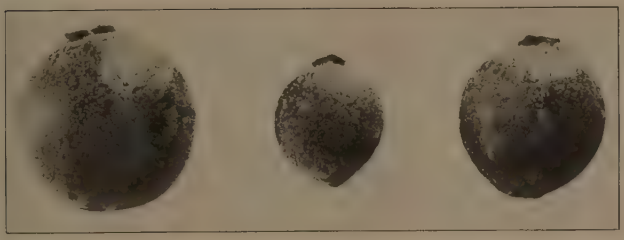

FIG. 2

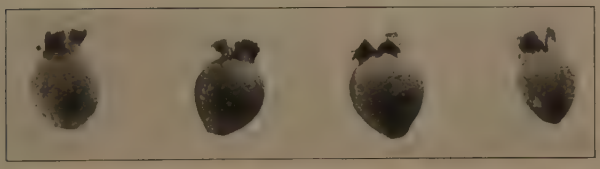

FIG. 3

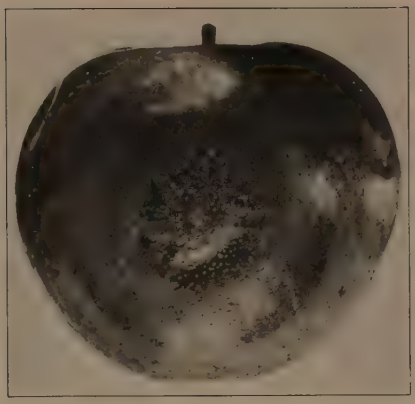

FIG. 1

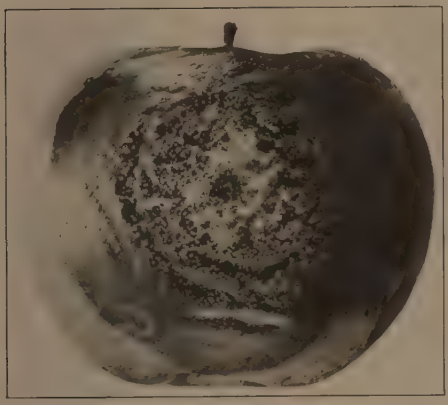

FIG. 2

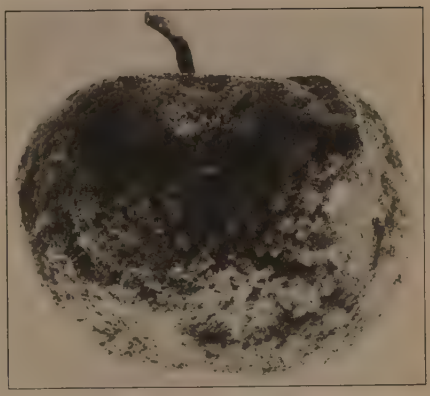

FIG. 3

FIG. 4

FIG. 1

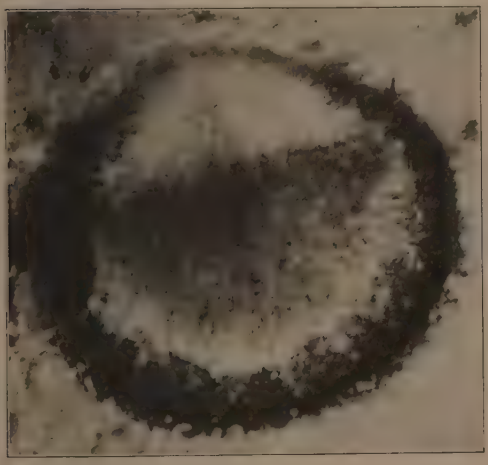

FIG. 2

FIG. 3

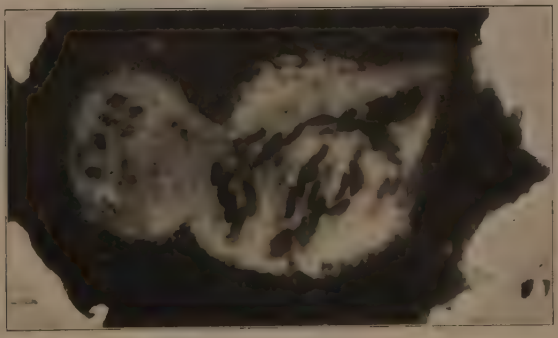

FIG. 4

PLATE IV